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USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK
Volume 146
F-16B In-Flight Crew Noise

AUGUST 1979

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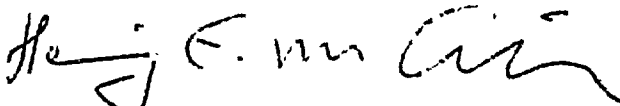
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FOR THE COMMANDER



HENNING E. VON GIERKE

Director

Biodynamics and Bioengineering Division
Aerospace Medical Research Laboratory

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The F-16B is a two-seated light-weight fighter. This report provides measured data defining the bioacoustic environments at the pilot's location inside this aircraft for 31 flight conditions. Data are reported for two locations in a wide variety of physical and psychoacoustic measures: overall and band sound pressure levels, C-weighted and A-weighted sound levels, preferred speech		

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interference level, perceived noise level, and limiting times for total daily exposure of personnel with and without standard Air Force ear protectors. Refer to Volume 1 of this handbook, USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application, AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.



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PREFACE

This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 723108, Crew Safety In Operational Noise Environments.

The author acknowledges the efforts of Mr. John N. Cole who established the data analysis requirements, Mr. Henry Mohlman and Mr. Fred Lampley of the University of Dayton who assisted in the mechanics of data processing and Mrs. Norma Peachey who typed this report and prepared it for publication.

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INTRODUCTION

The F-16B is a USAF light-weight fighter manufactured by the General Dynamics Corporation. This aircraft is powered by one F-100-PW-200(3) turbofan engine rated at 25,000 lbs. maximum takeoff thrust with afterburner. The engine is manufactured by the United Aircraft Corporation, Pratt & Whitney Division.

This volume provides measured data defining the bioacoustic environments produced inside this aircraft. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the F-16B aircraft.

This volume is one of a series published by the Aerospace Medical Research Laboratory (AMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and ground support equipment. The far-field, community-type, noise data in the handbook describe the noise produced during *ground operations* of aircraft, ground support equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. *Refer to Volume 1* (reference 1) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., in-flight/flight crew and passenger noise, near-field/ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published, and is available upon request from AMRL/BBE, Wright-Patterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of the updated index as it is generated.

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1. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application*, AMRL-TR-75-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio 1975.

IN-FLIGHT NOISE

MEASUREMENTS

All noise measurements were made on-board a F-16B aircraft during typical speed, altitude, and flight maneuver conditions. These levels describe the standard F-16B environments but may not be representative of those levels encountered if the aircraft has been configured differently (e.g., major equipment or structural changes).

Acoustic measurements were made inside the cockpit at the pilot's location. Table 1 lists the measurement location and test conditions as numeric/alphabetic designators which are used on the data pages. The designator 1/A means measurement location 1 and test condition A, etc.

The microphone was attached to the pilot's helmet by means of a lightweight boom. This arrangement enabled adjustment of the microphone close to the ear level at a distance of 0.1 meter with its diaphragm parallel and facing away from the helmet's surface. In the analysis, microphone corrections for random incidence were applied to the overall systems response. The recorded samples were analyzed using a four or eight second integration time to obtain a power-averaged level which effectively smooths out short duration fluctuations and best describes the exposure.

Results

The measured data presented in Table 2 define the sound pressure levels (SPL) produced inside the F-16B aircraft at the specified location. This table includes the overall, $\frac{1}{3}$ octave band, and octave band levels. From these data, C-weighted and A-weighted sound levels, maximum permissible time for one exposure per day (AFR 161-35) with and without standard Air Force ear protectors, preferred speech interference level, and perceived noise level are calculated and presented in Table 3. These measures are widely used to assess the effects of noise on personnel and their performance.

TABLE 1

MEASUREMENT LOCATIONS AND TEST CONDITIONS
F-16B, Edwards AFB CA, 12 June 1979

<i>Location</i>	<i>Position</i>	<i>Height Above Deck</i>
1	Pilot Front Seat	Seated Head Level
2	Copilot Back Seat	Seated Head Level

<i>Condition</i>	<i>Description</i>
Front Seat	
A	Ground run up - engine speed 75% N ECS Source - OFF (Canopy closed)
B	Ground run up - engine speed 75% N ECS Air Source - Norm Temp. control - comfortable Auto position Defog - Full AFT position
C	Ground run up - engine speed 75% N ECS Air Source - Norm Temp. control - Manual warm position short of thermostat cycling Defog - Full AFT position
D	Normal MIL Power takeoff FCR - STBY Air Source - Norm Temp. control - comfortable Auto Defog - Full AFT position
E	MIL Power climb to 5000'
F	Cruise at 5000' - Speed 488 KIAS - .8M
G	Cruise at 5000' - Speed 488 KIAS - .8M Defog - MAX Defog
H	Cruise at 5000' - Speed 488 KIAS - .8M Temp. control - Comfortable Manual Defog - Full AFT position
I	Cruise at 5000' - Speed 488 KIAS - .8M Temp control - Manual warm (short of thermostat cycling) Defog - Full AFT position

Condition
Front Seat

Description

J	<p>MIL Power climb 5000' - 30000'</p> <p>Speed 488 KIAS - .8M to 304 KIAS - .8M</p> <p>Air Source - Norm</p> <p>Temp. control - Auto (mid)</p> <p>Defog - Full FWD position</p>
K	<p>Cruise at 30000'</p> <p>Speed 304 KIAS - .8M</p> <p>Air Source - Norm</p> <p>Temp. control - Auto (mid)</p> <p>Defog - Full FWD position</p>
L	<p>Descent from 30000' to 25000'</p> <p>Speed 304 KIAS - .8M - 338 KIAS - .8M</p> <p>Idle Power, S/B out</p> <p>Air Source - Norm</p> <p>Temp. control - comfortable Auto</p> <p>Defog - MAX Defog</p>
M	<p>Cruise at 25000'</p> <p>Speed 338 KIAS - .8M</p> <p>Air Source - Norm</p> <p>Temp. control - Auto (mid)</p> <p>Defog - Full FWD position</p>
N	<p>Descent from 25000' to 20000'</p> <p>Speed 338 KIAS' - .8M - 373 KIAS - .8M</p> <p>Idle Power, S/B out</p> <p>Air Source - Norm</p> <p>Temp. control - Auto (mid)</p> <p>Defog - Full FWD position</p>
O	<p>Cruise at 20000'</p> <p>Speed 373 KIAS - .8M</p> <p>Air Source - Norm</p> <p>Temp. control - Auto (mid)</p> <p>Defog - Full FWD position</p>
P	<p>Cruise at 20000'</p> <p>Speed 373 KIAS - .8M</p> <p>Air Source - OFF</p>

Condition
Front Seat

Description

Q	Descent from 20000' to 5000' Idle Power - S/B out Air Source - Norm Temp. control - Auto (mid) Defog - Full FWD position
R	Cruise at 5000' Speed 488 KIAS - .8M Air Source - Norm Temp. control - Manual Defog - Full FWD position
S	MIL Power climb to 5000' to 40000' Speed 0.8M Temp. control - Auto (mid) Defog - MAX
T	Hi-speed run 40000' - .8M to 1.12M Air Source - Norm Temp. control - Auto (mid) Defog - MAX
U	Descent from 40000' to 20000' Idle Power - S/B out
V	Air combat maneuvering (20000') Air Source - Norm Temp. control - comfortable Auto Defog - Full AFT position
W	Descent 20000' to 10000' Idle Power - S/B out Air Source - Norm Temp. control - comfortable Auto Defog - Norm
X	Hi-speed run 1000' - .8M to 1.12M Air Source - Norm Temp. control - comfortable Auto Defog - Full AFT position
Y	Descent 10000' to 5000' Speed 448 - .8M to 488 KIAS - .8M Air Source - Norm Temp. control - comfortable Auto Defog - MAX

<i>Condition</i>	<i>Description</i>
Z	Landing and roll out Air Source - Norm Temp. control - Auto (mid) Defog - Full FWD position
Back Seat	
A	Ground run up - engine speed Idle Air Source - Norm Temp. control - comfortable Auto
B	Normal MIL Power takeoff Air Source - Norm Temp. control - comfortable Auto
C	Cruise at 7500' - speed 250 KIAS Air Source - Norm Temp. control - comfortable Auto
D	Descent from 14000' to 5000' Idle Power - S/B out Air Source - Norm Temp. control - comfortable Auto
E	Normal landing traffic pattern

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)														IDENTIFICATION:	
1/3 OCTAVE BAND															
2															
NOISE SOURCE/SUBJECT: (OPERATION:)														OMEGA 3.2	
F-16B AIRCRAFT														TEST AK-079-001	
IN-FLIGHT CREW NOISE														RUN 01	
()															
()														23 JUL 79	
()															
()														PAGE F1	
()															
LOCATION/CONDITION															
1/A 1/B 1/C 1/D 1/E 1/F 1/G 1/H 1/I 1/J 1/K 1/L 1/M 1/N															
FREQ (HZ)															
25														77	
31.5														75	
40														91	
50														83	
63														83	
80														77	
100														86	
125														95	
160														88	
200														88	
250														89	
315														87	
400														87	
500														90	
630														92	
800														88	
1000														91	
1250														87	
1600														86	
2000														84	
2500														83	
3150														82	
4000														84	
5000														85	
6300														83	
8000														82	
10000														77	
12500														73	
OVERALL														101	
LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.															

TABLE: MEASURED SOUND PRESSURE LEVEL (03)												
2 1/3 OCTAVE BAND												
NOISE SOURCE/SUBJECT: (OPERATION:) IDENTIFICATION:)												
F-15B AIRCRAFT () OMEGA 3.2												
IN-FLIGHT CREW NOISE () TEST AK-079-001												
() RUN 02												
() 23 JUL 79												
() PAGE F2												
LOCATION/CONDITION												
FREQ (HZ)	1/0	1/P	1/Q	1/R	1/S	1/T	1/U	1/V	1/W	1/X	1/Y	1/Z
25	71	76	75	74	78	66	65	80	75	81	82	77
31.5	72	72	76	76	77	66	64	81	76	79	81	76
40	83	82	92	88	89	76	78	90	99	87	91	89
50	76	74	85	82	86	70	76	80	92	79	87	86
63	73	72	79	80	81	66	72	75	78	77	82	82
80	84	85	91	91	93	78	79	87	92	90	92	89
100	90	94	97	99	95	81	88	88	96	92	100	91
125	86	87	90	93	91	79	82	85	89	89	93	89
160	87	88	87	95	92	91	81	88	88	95	92	85
200	90	91	88	98	94	82	84	90	92	93	93	89
250	90	90	90	98	95	90	82	94	92	95	95	88
315	88	88	89	94	94	81	81	91	92	94	94	88
400	89	89	90	95	94	81	81	89	89	93	92	89
500	92	91	92	97	96	85	84	92	92	96	94	90
630	93	92	92	98	95	84	84	92	91	97	95	93
800	92	89	88	96	94	82	81	91	88	96	92	93
1000	88	86	86	96	94	80	81	88	87	94	89	91
1250	91	85	87	95	94	81	84	85	84	92	87	93
1600	89	83	86	95	94	80	82	83	82	89	84	94
2000	88	82	85	94	93	79	82	81	80	88	82	94
2500	86	81	82	92	92	76	79	79	77	86	79	92
3150	86	80	82	92	93	76	79	77	77	86	80	92
4000	88	78	83	94	95	78	82	77	78	85	80	94
5000	87	80	82	94	93	75	80	75	75	83	79	94
6300	87	76	82	94	94	76	79	78	77	85	77	95
8000	84	74	79	91	91	73	75	77	82	80	74	91
10000	83	73	78	89	90	72	74	77	76	79	71	98
12500	80	70	74	84	84	70	70	73	75	74	68	85
OVERALL	102	101	103	109	107	96	96	102	102	106	105	105

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

[illegible]

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)		IDENTIFICATION:													
3		OCTAVE BAND													
NOISE SOURCE/SUBJECT:		OPERATIONS:													
F-16B AIRCRAFT		(
IN-FLIGHT CREW NOISE		(
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TABLE: MEASURED SOUND PRESSURE LEVEL (DB)		IDENTIFICATION:											
3													
OCTAVE BAND													
NOISE SOURCE/SUBJECT:		OPERATION:											
F-16B AIRCRAFT													
IN-FLIGHT CREW NOISE													
		LOCATION/CONDITION											
FREQ (HZ)		1/O	1/P	1/Q	1/R	1/S	1/T	1/U	1/V	1/W	1/X	1/Y	1/Z
31.5		84	83	92	88	90	77	76	90	89	88	92	89
63		85	86	92	92	92	79	81	88	93	90	93	91
125		93	96	98	101	97	92	90	92	98	97	101	94
250		94	94	94	102	99	91	87	97	96	99	99	93
500		96	95	96	101	100	88	88	96	95	100	98	96
1000		95	91	92	101	98	86	87	93	91	99	95	97
2000		93	87	89	98	98	83	86	86	85	93	87	98
4000		92	84	87	98	98	81	85	81	81	89	84	98
8000		89	79	85	96	97	78	82	82	84	87	79	97
OVERALL		102	101	103	109	107	96	96	102	102	106	105	105

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)		IDENTIFICATION:	
3	OCTAVE BAND		
NOISE SOURCE/SUBJECT:		OMEGA 3.2	
F-16B AIRCRAFT		TEST AK-079-301	
IN-FLIGHT CREW NOISE		RUN 83	
		23 JUL 79	
		PAGE J3	
		</	

TABLE: MEASURES OF HUMAN NOISE EXPOSURE											
4											
NOISE SOURCE/SUBJECT: (OPERATION:) IDENTIFICATION:)											
F-16B AIRCRAFT () OMFGA 3.2											
IN-FLIGHT CREW NOISE () TEST AK-079-001											
() RUN 12											
() 23 JUL 79											
() PAGE H2											
LOCATION/CONDITION											
1/O	1/P	1/Q	1/R	1/S	1/T	1/U	1/V	1/W	1/X	1/Y	1/Z
HAZARD/PROTECTION											
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DB) AT EAR											
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DB) AT EAR											
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)											
NO PROTECTION											
OASLC	132	161	103	108	137	96	95	101	102	105	105
OASLA	100	97	98	106	105	92	93	97	97	103	99
T	30	50	42	11	13	120	161	50	50	18	36
HGU-2A/P HELMET WITH H-154											
OASLA*	86	67	89	95	93	84	81	89	39	92	91
T	240	285	240	71	101	460	807	202	232	121	143
HGU-2A/P HELMET WITH H-154(A)											
OASLA*	83	83	84	96	89	80	76	85	85	68	87
T	571	571	480	170	243	960	960	404	434	240	285
HGU-2A/P HELMET WITH CUSTOM LINER											
OASLA*	94	93	93	100	98	88	87	94	33	93	96
T	85	101	101	30	42	240	285	85	101	42	60
COMMUNICATION											
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)											
PSIL	35	91	92	100	99	66	87	92	91	97	93
ANNOYANCE											
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PND3)											
TONE CORRECTION (C IN DB)											
PNLT	114	110	112	121	120	117	108	110	110	115	113
C	1	1	1	1	1	2	1	1	1	1	1
* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.											

TABLE: MEASURES OF HUMAN NOISE EXPOSURE				IDENTIFICATION:			
4				OMEGA 3.2			
NOISE SOURCE/SUBJECT:				TEST AK-079-001			
F-16B AIRCRAFT				RUN 03			
IN-FLIGHT CREW NOISE				23 JUL 79			
				PAGE M3			
				LOCATION/CONDITION			
				4/A	2/B	2/C	2/E
HAZARD/PROTECTION							
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DB) AT EAR							
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DB) AT EAR							
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)							
NO PROTECTION							
OASLC				94	104	103	102
OASLA				90	101	90	98
T				170	25	36	42
HGU-2A/P HELMET WITH H-154							
OASLA*				78	89	91	89
T				960	202	170	202
HGU-2A/P HELMET WITH H-154(A)							
OASLA*				74	85	85	85
T				960	404	339	404
HGU-2A/P HELMET WITH CUSTOM LINER							
OASLA*				84	96	93	93
T				480	60	101	85
101							
COMMUNICATION							
PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)							
PSIL				84	96	93	92
ANNOYANCE							
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)							
TONE CORRECTION (C IN DB)							
PNLT				106	113	114	112
C				1	1	1	1
3							

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.